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Laid Open Utility Model: Heisei 6-62786

name of the utility model: Synchronous Linear Motor
applicant: Yaskawa
date of application: Jan. 29, 1993
laid open date: Sep. 2, 1994

[summary]

[purpose of the utility model]

This idea relates to a cooling structure of synchronous linear motor having a flat armature coil and permanent magnet field and aims to offer a thermal deformation-free synchronous linear motor where thermal transfer to magnetic field area and coil holder is prevented,

[structure]

In a synchronous linear motor where
a flat plate armature coil 1 of a stator 20 consisting of the flat plate armature coil 1 and a coil holder 3 having a groove 31 arranged in the moving direction of a movable element 10 faces to the movable element 10 having field poles 5 made of multiple number of permanent magnets through air gaps,
rectangular pipe-shaped jackets 2a and 2b which have roles as reinforcing member and coolant path are linked together by thin plate bridge 23 made of elastic body,
the flat armature coil 1 is sandwiched by jackets 2a and 2b by its sides and
the bottom 21 of jackets 2a and 2b is inserted, keeping elasticity, in the groove 31 of the coil holder 3 arranged in the moving direction.

[range of claims]

[claim 1]

In a synchronous linear motor where
a flat plate armature coil (1) of a stator comprising said plate-shaped flat armature coil (1) and a coil holder having a groove in the moving direction of a movable element (10) faces to, through air gaps,
a movable element (10) having field yokes (6 and 6) connected by a plate (61) and magnetic field poles (5) made of multiple number of permanent magnets,

a synchronous linear motor comprising:
rectangular pipe-shaped jackets (2a and 2b) sandwiching said flat armature coil (1) by its sides;
thin elastic plate bridge (23) which connects the upper part of jackets (2a and 2b); and
a coil holder (3) having a groove (31) into which the bottom (21) of jackets (2a and 2b) are inserted, keeping elasticity.

[claim 2]
A synchronous linear motor described in claim 1 wherein
the thin, elastic plate bridge (23) which connects the top of said jackets (2a and 2b) is substituted by a clip (24).

[claim 3]
A synchronous linear motor characterized in that
two sets of the flat armature coil (1), jacket (2a and 2b) and bridge (23) described in either claim 1 or 2 are arranged in parallel;
two grooves (31) described in claim 1 or 2 are arranged on the coil holder (32) in parallel;
an E-shaped plate (62) has the long center leg and connects the field yokes (6 and 6); and
a field pole (51) are arranged in the center part of the plate (62).

[claim 4]
A synchronous linear motor described in claim 3, characterized in that
said field pole (51) is substituted by a back yoke (52).

[brief explanation of figures]
Fig. 1 is a cross section to illustrate an embodiment according to this idea.
Fig. 2 is a flat view of an armature coil used in an embodiment of this idea.
Fig. 3 is a cross section of the jackets used in an embodiment of this idea.
Fig. 4 is a perspective view of a stator used in an embodiment of this idea.
Fig. 5 is a cross section to illustrate the second embodiment of this idea.
Fig. 6 is a cross section to illustrate the third embodiment of this idea.
Fig. 7 is a cross section to illustrate the fourth embodiment of this idea.

[code]

1	flat armature coil

2a, 2b	jacket
22	coolant path
23	bridge
24	clip
3, 32	coil holder
31	groove
4	end plate
41	connecting pipe
42a	supply pipe
42b	discharge pipe
5, 51	field pole
52	back yoke
5a, 5b....	permanent magnet
6	field yoke
61, 62	plate
10	movable element
20	stator

[detailed explanation of the idea]

[001]

[industrial application]

This idea relates to a cooling structure of synchronous linear motors having flat armature coil and permanent magnetic field; this idea is particularly appropriate for the purposes such as driving of a stepper to fabricate semiconductors which demands ultra accuracy and high thrust.

[002]

[prior art]

Conventionally, there has been a synchronous linear motor (e.g., laid open utility model Heisei 4-128085; see Fig. 3) wherein;

flat armature coils (e.g., laid open utility model Heisei 1-157579) are adhered on both surfaces of a flat plate coil fixing frame and

the flat armature coil of a stator where the bottom of a coil fixing frame is fixed on a stator base through coil holder faces to, through air gap, a movable element having field pole made of multiple

number of permanent magnets.

[003]

[issues this utility model tries to solve]

Without cogging nor magnetic attraction between the armature and magnets, above synchronous linear motor is supposed to be appropriate for the purpose of ultra accuracy positioning. When the stator is fixed on a base and a slider is attached to the movable element, a moving table for semiconductor manufacturing stepper is constituted.

Whereas, the prior art has had the following problems:

1) As the surface of armature coil which generates heat and that of field permanent magnets are facing each other through a small air gap, heat is conducted or irradiated through the air gap to magnet parts, further goes to the slider through field part; thermal expansion of the slider causes a deformation, which makes it inappropriate for the use where ultra-level accuracy positioning is demanded.

2) The heat generated at armature coil is transferred to the coil holder through coil fixing frame and raises the temperature of base, which results in thermal deformation on the stator side.

3) The attempt to use a flat armature coil as a stator without fixing it to a frame fails to attain desired straightness in the moving direction due to inadequate stiffness.

The purposes of this idea are to cool said armature coil, prevent thermal transfer to field part or the coil holder and offer a stator with high stiffness.

[004]

[means to solve the problems]

In order to solve aforementioned problems,

in a synchronous linear motor where

a flat armature coil (1) of a stator comprising the flat armature coil (1) and a coil holder (3) having a groove (31) arranged in the moving direction of a movable element (10) faces to, through air gaps, the movable element (10) having field poles (5) made of multiple number of permanent magnets, said flat armature coil (1) is sandwiched by its sides by rectangular pipe-shaped jackets (2a and 2b) working as coolant paths as well as reinforcing members and

the bottom (21) of the jackets (2a and 2b) is inserted, with elasticity, in the groove (31) arranged in the moving direction on the coil holder (3).

[005]
[operation]
On account of above means, heat generated at the flat armature coil is exchanged by the coolant flowing inside the jackets when the flat armature coil is directly cooled; heat transfer/irradiation to field poles can be reduced and temperature rise of the movable element and stator can be kept small. By using jackets having relatively high stiffness, a flat armature coil having small stiffness obtains a more desirable straightness.

[006]
[embodiment]
Following is the explanation of embodiments of this idea referring to Fig. 1 to 4.
Both sides of flat band armature coil 1 (see Fig. 2) formed by bending three element coils (U, V and W) at a specified pitch and a specified angle and shifting each other by 120° electric phase are inserted between relatively thin, rectangular pipe-shaped jackets 2a and 2b which are made of nonmagnetic material and serve as coolant paths 22. The distance between jackets 2a and 2b is slightly shorter than the thickness of the flat armature coil 1, by which the straightness of the flat armature coil 1 with low stiffness can be corrected.

The top of the rectangular pipe-shaped jackets 2a and 2b is, as shown in Fig. 3, is connected by the thin plate bridge 23 made of nonmagnetic elastic body by means as welding etc. and the bottom of the rectangular pipe-shaped jackets 2a and 2b is slightly ajar to each other in the status where the flat armature coil 1 is inserted between them.

In the center of the coil holder 3 made of material with small thermal conductivity, groove 31 slightly narrower than the width of the jackets 2a and 2b when the flat armature coil 1 is inserted between them is arranged in the moving direction of the movable element 10.

The bottom of the jackets 2a and 2b sandwiching the flat armature coil 1 is inserted in the groove 31 arranged in the middle of the coil holder 3, with elasticity.

End surfaces of jacket 2a and 2b in the moving direction of the movable element are, as shown in

Fig. 4, sealed in a liquid-tight manner by end plates 4 and 4. On one end, a U-shaped connecting pipe 41 is arranged to both end plates, and the center of U-shaped pipe is connected to a supply pipe 42a. The other side of the end is arranged in the same way, except the center of U-shaped pipe is connected to a discharge pipe 42b.

The stator 20 is constituted by the flat armature coil 1, jackets 2a and 2b, bridge 23, coil holder 3, end plates 4, connecting pipes 41 and inlet and outlet pipes 42a and 42b.

On both sides of jackets 2a and 2b, multiple number of permanent magnets 5a and 5b face to each other through air gaps; the arrangement of magnetic poles on 5a and 5b is in such a way that the adjacent poles in the moving direction of the movable element are unlike each other, and so are the facing poles.

Field poles 5 and 5 are, in the same manner as in the prior art, fixed on the field yokes 6 and 6 made of ferromagnetic material. The top of the field yokes 6 and 6 are connected by a plate 61 made of nonmagnetic, lightweight material.

The movable element 10 is constituted by the field poles 5 and 5, field yokes 6 and plate 61.

The embodiment is a moving magnet type where the movable element 10 has field poles 5 and 5; it can be a moving coil type where the movable element 10 and stator 20 of the embodiment are reverse, in which case, flexible pipes can be used to send coolant to the supply pipe 42a and discharge pipe 42b.

Fig. 5 shows the second embodiment.

In this embodiment, jacket 2a and 2b are separately structured and the flat armature coil 1 is sandwiched by them; the flat armature coil 1, jackets 2a and 2b are inserted in the groove 31 arranged in the middle of the coil holder 3, where there remain openings between the flat armature coil 1 and top of jackets 2a and 2b; pressing both jackets 2a and 2b from the side toward the center, tops of the flat armature coil 1, jackets 2a and 2b are gathered and fastened by a pre-loaded clip 24 having the width slightly narrower than the total width of the flat armature coil 1 and jackets 2a and 2b.

Fig. 6 illustrates the third embodiment, where two rows of the stators 20 are arranged in parallel, the width of the coil holder 3 is approximately twice as much as that of the (*first*) embodiment, and there are two rows of the groove 31. The plate 61 of the (*first*) embodiment is substituted by E-shaped plate 62 the width of which is approximately 1.5 times as much as the plate 61, having a lowered part in the middle, where field magnet 51 similar to the permanent magnets 5a, 5b, etc. of the field pole 5 is inserted.

Fig. 7 illustrates the fourth embodiment. The field pole 51 (*5b??*) set in the center of the third embodiment is substituted by the back yoke 52 made of ferromagnetic material in this embodiment.

The structures such as in the third and fourth embodiments make it possible to realize inexpensive, compact linear motors with high thrust.

[007]
[effects of the invention]
As mentioned above, this idea has the effects as follows:

1. Since the air gap is cooled by the jackets, thermal transfer/irradiation to field poles is prevented; thus deformation of the movable element is prevented as well.

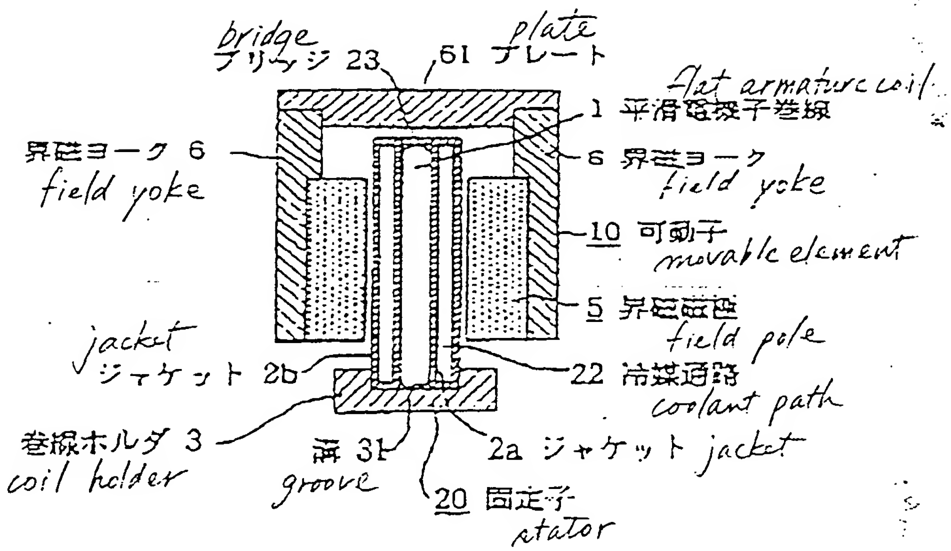
2. The armature coil is effectively cooled almost directly by side surfaces of jackets.

3. Due to the structure where coolant goes through the jackets, nonconductor coolant is not necessary, allowing us to realize inexpensive cooling apparatus.

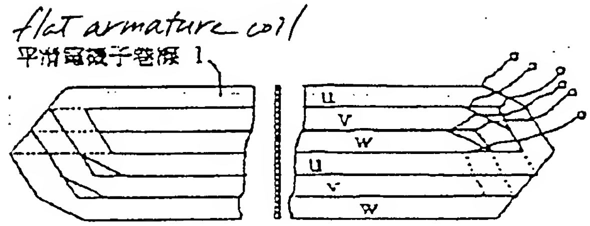
4. Straightness of the stator can be maintained by correcting (*the position of*) armature coil by the jackets with relatively high stiffness.

5. Even though excessive cooling occurs, the flat armature coil is securely fixed because the jackets are maintained in the groove with elasticity.

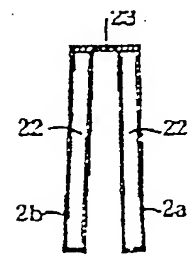
[Fig. 1]


bridge
ブリッジ 23
61 プレート
plate
flat armature coil
1 平滑電機子巻線
界磁ヨーク 6
field yoke
6 界磁ヨーク
field yoke
10 可動子
movable element
5 界磁磁極
field pole
jacket
ジャケット 2b
22 冷媒通路
coolant path
巻線ホルダ 3
coil holder
溝 31
groove
2a ジャケット jacket
20 固定子
stator

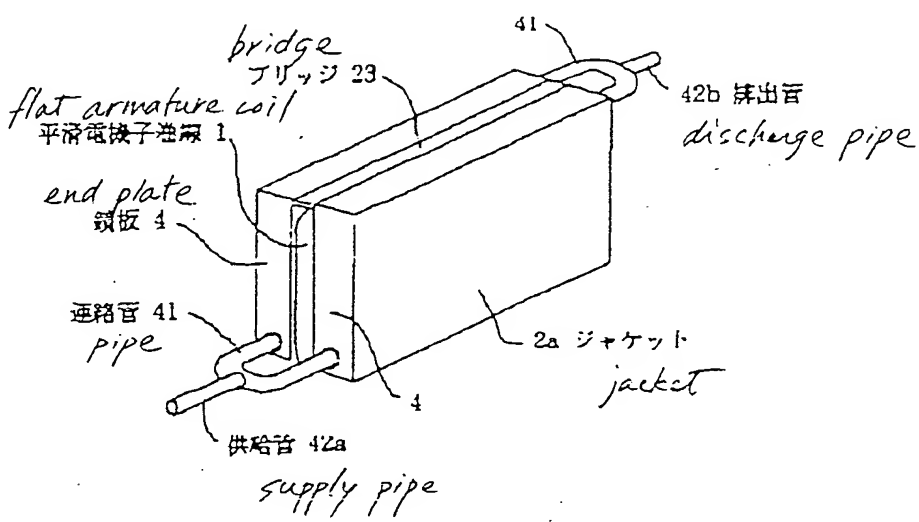
【図2】


flat armature coil
平滑電機子巻線 1
u
v
w
u
v
w

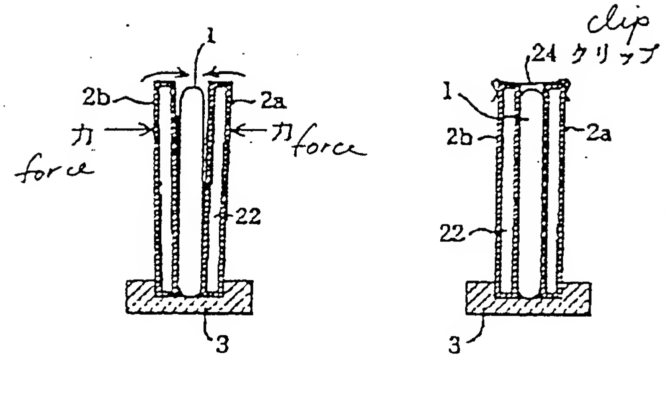
【図3】


23
22
22
2b
2a

【図4】


41
bridge
ブリッジ 23
42b 排出管
discharge pipe
flat armature coil
平滑電機子巻線 1
end plate
端板 4
連絡管 41
pipe
4
2a ジャケット
jacket
供給管 42a
supply pipe

【図5】



1
2b
2a
力
force
力
force
22
3
24 クリップ
clip
1
2b
2a
22
3

(a) (b)

【図6】

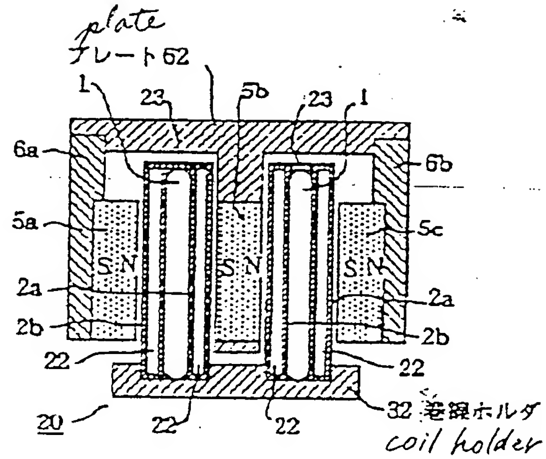
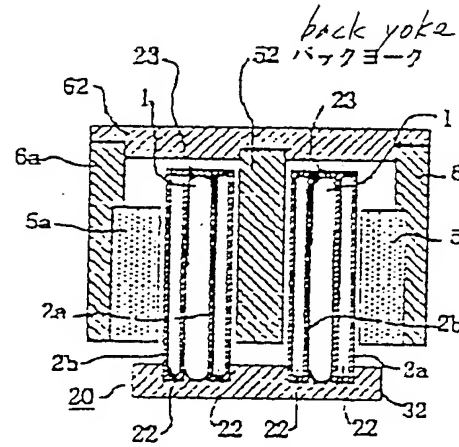


plate
プレート62
1
23
5b
23
1
6a
6b
5a
5c
2a
2a
2b
2b
22
22
20
22
22
32 巻線ホルダ
coil holder

【図7】



back yoke
52 バックヨーク
23
62
1
23
1
6a
6b
5a
5b
2a
2b
2b
2a
20
22
22
22
22
32